Economics Bulletin

Volume 40, Issue 4

Physics in tourism: Modeling destination growth

Jose F. Perles-Ribes
University of Alicante

Ana B. Ramón-Rodríguez
University of Alicante

Maria J. Such-Devesa
University of Alcalá

Abstract

Before the outbreak of the COVID-19 pandemic, the problem of tourist destination saturation or overtourism was a hot research topic among tourism researchers. The debate was focused on the definition and measurement of the phenomenon and on establishing the conceptual models that explain it. The objective of this note is to propose the use of Newton's Second Motion Law to model the growth of destinations and its derivation in potential issues of overtourism. This theory allows to incorporate more adequately relevant concepts in this context such as resistance to growth than other standard theories in the existing literature.

Citation: Jose F. Perles-Ribes and Ana B. Ramón-Rodríguez and Maria J. Such-Devesa, (2020) "Physics in tourism: Modeling destination growth", *Economics Bulletin*, Volume 40, Issue 4, pages 2859-2864
Contact: Jose F. Perles-Ribes - jose.perles@ua.es, Ana B. Ramón-Rodríguez - anar@ua.es, Maria J. Such-Devesa - mjesus.such@uah.es.
Submitted: September 01, 2020. **Published:** October 23, 2020.

Economics Bulletin

Submission Number: EB-20-00875

PHYSICS IN TOURISM: MODELING DESTINATION GROWTH

Jose F. Perles-ribes
University of Alicante

Ana B. Ramón-rodríguez
University of Alicante

Maria J. Such-devesa
University of Alcalá

Abstract

Before the outbreak of the COVID-19 pandemic, the problem of tourist destination saturation or overtourism was a hot research topic among tourism researchers. The debate was focused on the definition and measurement of the phenomenon and on establishing the conceptual models that explain it. The objective of this note is to propose the use of Newton's Second Motion Law to model the growth of destinations and its derivation in potential issues of overtourism. This theory allows to incorporate more adequately relevant concepts in this context such as resistance to growth than other standard theories in the existing literature.

Submitted: September 01, 2020.

The growth and sustainability of tourist destinations is an issue that has concerned researchers for many years. The Butler's (1980) lifecycle concept provided a theoretical notion of growth of tourism destinations being the standard in the literature.

Until the outbreak of the COVID-19 pandemic, the tourism industry was undergoing accelerated changes – specifically the emergence of the sharing economy and its influence on the degree of overtourism perceived in tourist destinations - which exacerbated the impacts of growth on tourist destinations by challenging the capacity of their managers and increasing the complexity for researchers (Milano, Cher & Novelli, 2019).

In this context, different studies have attempted to shed light on the definition of the phenomenon and its causes and effects, proposing explanatory conceptual models (e.g. Peeters et al., 2018) and different methods for measuring the phenomenon, including machine learning techniques (Perles, Ramón, Moreno & Such, 2020).

The preliminary results of these investigations are promising. However, as is often the case in novel research topics, it seems that the ad-hoc theoretical proposals made with respect to the phenomenon under study lack foundations or clear justification in the more consolidated theories of the sciences that support it (sociology, economics, etc.). In particular, in the case of destination growth and overtourism, beyond references to the complexity of the phenomenon, there is a lack of justification for the functional form of the relations analyzed and how they relate to the different models of economic or ecological growth.

The aim of this research note is to contribute to filling this gap in the literature by proposing the use of a traditional theory of physics (Newton's Second Law of Motion) as an empirical framework to analyze the phenomenon. The application of Newton's laws and concepts to economics and tourism is not new, since abundant literature on international trade and tourist flows and demand modeling is based on another of his emblematic models: the gravitational model (Witt & Witt, 1995). Moreover, attempting to improve the Butler's life cycle theory by incorporating supply-side aspects shows that gravitational and centripental versus centrifugal forces are also at the core of the evolutionary patterns of territorial tourism development proposed in the framework of the New Economic Geography (Papathedorou, 2003, 2004; Stabler, Papatheodorou & Sinclair, 2010).

According to Papathedorou (2004), the dynamics of the tourism market lead to a dualism between large conglomerates following oligopolistic rules and a myriad of small companies operating in monopolistic competition. These market dynamics are reflected at the territorial level, due to the action of agglomeration economies and centrifugal and centripetal forces acting in this context, which conditions a dual development of tourist resorts and destinations. The interactions of two dualisms (market and territorial dualism) results in a dual dualism of the tourism destinations evolutionary pathway.

This conceptual framework is fully mathematically modeled in Papathedorou (2003) where the derivation of the maximum level of utility for tourist leads to a system of equations for the indirect utility of each resort over time that can be solved using a process similar to Newton's optimization technique (Papathedorou; 2003:419), although the results indicate that tourists would prefer resorts rich in natural resources and/or marketed under competitive conditions.

Closely linked to this conception of inertia and resistance or centrifugal or centripetal forces that affect the development of tourist destinations, the most novel aspect of this article is that it focuses on the relevant concept of resistance to growth and the possibility of estimating it from the demand and growth models that currently exist in the tourism literature.

Newton's Second Motion Law can be formally stated as follows: The acceleration of an object as produced by a net force is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object (Newton, 1729). In mathematical notation, this law corresponds to the well-known formula $F=ma$ where F is the vector sum of the forces, m is the mass of that object and a is its acceleration.

Decomposing in F the forces acting for and against the movement, the following expression is obtained

$$mg - kv = ma \quad Equation\ (1)$$

In (1) mg represents the forces acting in favor (g is gravity) and kv represents the forces acting against (k is the air resistance) which depend on the velocity of the destination (v). In physics, being $a=dv/dt$, the resolution of (1) for $v(t)$ implies solving a differential equation with the general solution (Piskunov, 1969:469) being of the type

$$v = Ce^{-\frac{k}{m}t} + \frac{mg}{k} \quad Equation\ (2)$$

The application of this model to tourist destination growth requires some level of abstraction. For example, with regard to F, the forces that favor growth would be related to the competitiveness and the success of destinations (Dwyer & Kim, 2003) and the destinations' stakeholders that most benefit from tourism growth (Nunkoo & Ramkissoon, 2012). Conversely, endogenous forces limiting growth would be their carrying capacity and sustainability (Perkumienė & Pranskūnienė, 2019), the attitude of residents towards tourism and the role played by the stakeholders less favored by tourism development.

Specifically, in equation (1), g would represent an inertial or natural growth of the destination, which would interact with its size (m) and a would represent the realized tourism growth rate. From equation (1) the different magnitudes of interest could be directly obtained using classical available variables. For example, the resistance to growth in tourist destinations (k) would be:

$$k = \frac{m(g-a)}{v} \quad (3)$$

In (3), a flow variable like velocity (v) -measured for example in kilometers or miles per hour -could be measured using classical demand flow variables such as arrivals per year at the destination or overnight stays. The size of the destination (*m*) could be measured through its area, population or the size of its tourism supply. Finally, the acceleration (*a*) would be calculated as the arrivals variation between two periods using the following formula

$$a = \frac{v_f - v_0}{t_f - t_0} \quad (4)$$

In addition to these elementary direct calculations, the equations would serve as a basis for making better estimates of these values by including more covariates affecting overtourism (e.g. the presence of the sharing economy) using regression techniques.

For example, taking logarithms on all the terms of (2), the following equation is obtained:

$$\log(v) = \log(C) + \log\left(\frac{g}{k}\right) - \frac{k}{m}t + \log(m) \quad (5)$$

Note the similarity of (5) with the commonly estimated demand models (e.g. using gravity models) in tourism which include time and destinations population as explanatory variables. Models take the form:

$$\log(arrivals) = \beta_0 + \beta_1 \log(Destination\ Population) + \beta_2 Time + \beta_j \log(covariate\ j) + error \quad (6)$$

Under Newtons' framework, assuming the intercept (β_0) is equivalent to the terms *log(C)+log(g/k)* in (5), from the coefficient (β_2) the destinations' growth resistance would be calculated as $k= -\beta_2 m$ (i.e $k= -\beta_2 Population$).

Another alternative pathway for estimations would be to solve *v* in (3) and to take logarithms on both sides of the equation obtaining

$$\log(v) = -\log(k) + \log(m) + \log(g - a) \quad (7)$$

Here, the difficulty is that *g* belongs to the set of the explanatory variables and is usually unobservable. However, note the similarity of (7) to the commonly estimated demand models of type (8) which include as explanatory variables the population of the destination and the arrivals growth rate, taking the form:

$$\log(arrivals) = \beta_0 + \beta_1 \log(Destination\ Population) + \beta_2 \log(Destination\ Growth) + \beta_j \log(Covariate\ j) + error \quad (8)$$

Under Newtons' framework, the intercept (β_0) would be related to the *-log(k)* element and would be interpreted, in some sense, as the destinations' growth resistance. Equation (7) or an adapted version such as (8) would be particularly well estimated using panel data techniques, where the intercept is allowed to change between destinations. The techniques used (e.g. instrumental variables) should address the potential endogeneity issues derived from the relationship existing between *v* and *a.*

The length of this note limits the idea from being developed in greater depth but serves as an example of the various possibilities of estimation that could exist. The most relevant point is that it draws attention to the concept of resistance to growth and its possibility of calculating it directly using the formulas and including it in new models estimating destination growth, or deriving it from the demand models found in the existing literature.

In fact, the tourism literature includes an abundance of estimated demand models like the ones presented here. But the contribution to literature of this note is that it focuses on an innovative reinterpretation of the coefficients estimated through this model. On the other hand, the lifecycle concept of Butler (1980) does not accommodate some of the concepts relevant in the tourism literature such as resistance to growth, which are better incorporated in this proposal.

For future research, this note opens the possibility for improving the model and revisiting some of these studies interpreting them under this framework and obtaining estimates of the resistance to growth for many tourist contexts and destinations.

As a limitation of this paper, a main drawback of the model, as presented here, is that it assumes that the mass *m* of the bodies remains constant, and this is not the general situation of tourist destinations whose growth in many cases is remarkable. However, there are versions of this theory that admit a non-constant mass and could be adapted to the tourism case. The development of this advanced version of the model can be used to take into account the supply-side aspects of the tourism development and potentially cross-check the results of the estimations carried out under this perspective with the empirical results obtained using the theoretical framework of Papathedorou, (2003, 2004) and Stabler, Papatheodorou & Sinclair (2010),

In any case, this note shows that the application of Newton's Second Motion Law to the problem of destination growth and the related problems of overtourism would be potentially feasible and would provide a theoretical foundation to the models estimated based on this methodology.

References:

Butler, R. (1980) "The Concept of a Tourist Area Cycle of Evolution: Implications for Management of Resources" *Canadian Geographer*, **25**, 5-12

Dwyer, L., Kim, C. (2003) "Destination competitiveness: determinants and indicators" *Current Issues in Tourism,* **6 (5)**, 369–414.

Milano, C., Cheer, J. M., Novelli, M. (Eds.) (2019). *Overtourism: Excesses, discontents and measures in travel and tourism*, CABI: Wallingford.

Newton, Sir Isaac; Machin, John (1729) *Principia. 1* (1729 translation ed.) p, 19.

Nunkoo, R., Ramkissoon, H. (2012) "Power, trust, social exchange and community support" *Annals of Tourism Research,* **39 (2)**, 997-1023.

Papathedorou, A. (2003) "Modelling Tourism Development – A Synthetic Approach" *Tourism Economics*, **9 (4)**, 407-430.

Papathedorou, A. (2004) "Exploring the Evolution of Tourist Resorts" *Annals of Tourism Research*, **31 (1)**, 219-237.

Peeters, P, Gössling, S., Klijs, J., Milano, C. Novelli, M., Dijkmans, C., Eijgelaar, E., Hartman, S., Heslinga, J., Issac, R., Mitas, O., Moretti, S., Nawijn, J., Papp, B., Postma, A. (2018). Research for TRAN Committee - *Overtourism: impact and possible policy responses*, European Parliament, Policy Department for Structural and Cohesion Policies: Brussels.

Perles, J., Ramón, A., Moreno, L., Such, M. (2020) "Machine learning techniques as a tool for predicting overtourism: The case of Spain" *International Journal of Tourism Research*, DOI: 10.1002/jtr.2383

Perkumienė, D., Pranskūnienė, R. (2019) "Overtourism: Between the right to travel and residents' rights" *Sustainability,* **11 (7)**, 2138.

Piskunov, N. (1969) *Differential and Integral Calculus*, Mir: Moscú

Stabler, M.J., Papatheodorou, A., Sinclair, T.M. (2010) *The Economics of Tourism*, 2nd Edition, Routledge: London

Witt, S. F., & Witt, C. A. (1995) "Forecasting tourism demand: A review of empirical research" *International Journal of Forecasting*, **11(3)**, 447–475.